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Evaluation of the Sustainability of Water and Sanitation Interventions in Central America after Hurricane Mitch

February 12 – 27, 2006

U.S. Centers for Disease Control and Prevention (CDC)

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Evaluation of the Sustainability of Water and Sanitation Interventions in Central America after Hurricane Mitch: February 12 – 27, 2006

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Center for Environmental Health
Agency for Toxic Substances and Disease Registry
Division of Emergency and Environmental Health Services

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Executive Summary

The American Red Cross (ARC) and Centers for Disease Control and Prevention (CDC) collaborated on a sustainability evaluation in communities that received ARC interventions in response to Hurricane Mitch in 1998. The sustainability evaluation of these interventions used indicators to measure continued effectiveness and performance of the interventions with no external support from ARC. This sustainability evaluation was conducted in 2006, four years after a 3-year survey was completed in 2002.

The goal of this evaluation was to determine the sustainability of the water and sanitation interventions implemented by ARC in Central America post-hurricane. Local community services had been disrupted as a result of the hurricane. A 3-year survey of the health improvements of the interventions was completed by CDC in February of 2000, 2001, and 2002. The survey was done in eight communities in four countries - El Salvador, Guatemala, Honduras and Nicaragua. Improvements in health were measured using indicators. This sustainability evaluation was conducted in six of the eight communities that received ARC interventions.

The sustainability evaluation was comprised of four components: a household-level interview, a community-level interview, water sampling and analysis from homes and community systems and an infrastructure evaluation. The household interview included a questionnaire that obtained data that focused on the three interventions - water, sanitation and hygiene education. Data collected evaluated hand washing behaviors, the condition of latrines, and the presence or absence of coliforms in household drinking water samples. The community-level and infrastructure questionnaires were the same as those used in the previous 3-year survey.

Our results show that the ARC post-Hurricane Mitch water and sanitation interventions were sustainable after four years on a regional basis. In communities with an active water committee with long-standing members, the ARC water systems were still functioning and being maintained. However, even when the water systems were well-managed, most experienced periodic service disruptions due to seasonal flood damage.

Introduction

In February 2006, the American Red Cross (ARC) and the Centers for Disease Control and Prevention (CDC) collaborated on a sustainability evaluation in Central America of ARC-funded water and sanitation interventions provided following Hurricane Mitch. This sustainability evaluation of post-disaster water and sanitation construction and hygiene education interventions is the first time ARC has examined its interventions over the long term.

Background

In the fall of 1998, Hurricane Mitch caused 10,000 deaths and left an estimated 500,000 people homeless in Central America. Local infrastructure in many communities was destroyed, leaving them without basic water and sanitation. In response, the ARC funded construction of local water and sanitation systems that included latrines and household- or community-level running water. These interventions were provided to over 75,000 people in 110 communities in El Salvador, Guatemala, Honduras, and Nicaragua.

In each community, ARC presented the costs and benefits of installing and maintaining a variety of water and sanitation systems. Community representatives selected which system to install on the basis of the level of services they believed the community would be willing and able to support. In addition, the ARC provided education on hygiene (e.g., handwashing techniques) and drinking water disinfection. The overall goal of the interventions was to provide sustainable improvement to the health of people living in the areas affected by the hurricane.

Summary of Previous Activities

At the request of ARC, investigators from the CDC conducted three annual surveys (i.e., in 2000, 2001 and 2002) to evaluate the effects of the ARC post-Hurricane Mitch interventions in two selected study areas from each of the four countries. During those surveys, CDC used metrics from the United States Agency for International Development (USAID) Food and Nutrition Technical Assistance (FANTA) Title 2 Water and Sanitation Indicators Measurement Guide (FANTA Guide) (Billig et al., 1999) to measure improvements in health as a result of the ARC interventions.

In February 2000, a baseline survey was conducted prior to the construction of water and sanitation systems and the presentation of hygiene education. Follow-up surveys were conducted during the dry season in February 2001 (mid-term) and February 2002 (final) to assess the health impact of the completed interventions. For each survey, CDC investigators interviewed household members and community water committee members about the viability of ARC-provided water systems and about sanitation and hygiene education. We inspected water systems from the source to the end-user and assessed water quality. We also inspected sanitation systems and examined the retention and application of hygiene education.

In all, 2309 households in 8 study areas were surveyed. A total of 265 household and 124 community water samples were collected and analyzed. Results of these surveys have been summarized and reported by CDC in a Final Report (Moll et al., 2002). The important metric of the health impact of the provision of water and sanitation services and hygiene education was the incidence of diarrhea among young children. Results from the three-year survey showed that improvements in health could be measured in the affected communities.

Purpose of the Sustainability Evaluation

A sustainability evaluation of the ARC-funded water and sanitation projects was recommended as a result of the three-year survey. This evaluation was conducted in the same communities previously surveyed. The purpose of this sustainability evaluation was to:

1) Examine the continued functioning and suitability of ARC-provided water and sanitation systems,

2) Measure the retention and application of hygiene education related to hand washing, water collection and treatment, and sanitation practices by individuals responsible for obtaining and storing household water.

Like the three previous surveys, this evaluation included interviewing randomly selected households, interviewing community water committees, sampling water in homes, community water systems, and water sources, and a water infrastructure evaluation. In addition, community and household questionnaires solicited information about natural disasters or other problems affecting the sustainability of water and sanitation systems since the last survey in 2002.

FANTA (Food and Nutrition Technical Assistance) Guide Indicators

ARC requested that CDC use the FANTA Guide indicators as the basis for measuring outcomes in the CDC three-year survey. Use of the FANTA Guide indicators provides a consistent set of performance indicators for assessing and reporting the effect of water and sanitation interventions in developing countries.

There are eight FANTA guide performance indicators which consist of four impact indicators and four monitoring indicators (provided in Appendix A). The impact indicators assess the effect of the interventions on the behaviors and health status of the beneficiaries, and include measures of disease burden, hygiene behavior, and maintenance and use of water supply and sanitation facilities. Monitoring indicators are used to evaluate the progress of the interventions in achieving programmatic goals. We were able to evaluate the ability of each community to meet each of the performance indicators.

Data collected for the three-year survey was meant to evaluate and demonstrate the effectiveness of ARC interventions on improving the health of the population impacted by the hurricane. The focus of the sustainability evaluation was to look at the long-term effectiveness of the water and sanitation infrastructure and retention of hygiene education. As a result of the three-year survey, we found that we were able to collect reliable data to estimate the four indicators presented in Table 1. Each of the indicators specifically addressed one of the interventions. We used the same goals as provided in the FANTA guide or the ARC recommended goal from the three-year survey.

Table 1. USAID FANTA Guide Indicators to Evaluate Program Sustainability

Intervention	Performance Indicator	Description Of Indicator	Goal
Water Infrastructure	Monitoring Indicator #1	Percent of households with year-round access to improved water source	100%*
Sanitation Infrastructure	Monitoring Indicator #2	Percent of households with access to sanitation facility	100%*
Hygiene	Impact Indicator #3	Percent of households with appropriate	50%

Education		hand washing behavior (food preparer)	Increase
	Impact Indicator #4	Percent of population using hygienic sanitation facilities	75% In use

* Goal not defined in the FANTA guide but by the American Red Cross.

Methods

The sustainability evaluation had four components:

1) A cross-sectional household survey, which included a questionnaire, visual inspection of water and sanitation facilities, and visual evaluation of hygiene behaviors

2) Qualitative water sampling of community water sources and stored household water for indicators of microbial contamination

3) A community survey conducted with one or more members of the community water committee and

4) An infrastructure inspection/evaluation of the physical community water system to assess the functionality, maintenance and sustainability.

Study Location

The study locations and communities chosen for the sustainability evaluation are listed in Table 2 and shown in Figure 1.

Table 2. Study Locations

Country	Study Areas	
El Salvador	Las Pozas	La Ceiba
Guatemala	Chiquimula (Plan Shalagua and Guayabo)*	---
Honduras	Marcovia	Las Lomas
Nicaragua	Nueva Segovia (Dipilto Nuevo and Dipilto Viejo)*	---

*Two communities grouped together as a study area so that a sufficient number of households could be surveyed

Figure 1. Study Location Map

Study location not included in the sustainability evaluation but part of the long term study.

Dipilto Nuevo and Dipilto Viejo received their water system from the local municipality rather than ARC. These two communities are retained in this evaluation as the ARC was interested in evaluating the effectiveness of the interventions in these communities and was easily accessible by road. Two study areas, Huitzitzil, Guatemala and Waspam, Nicaragua, participated in our earlier surveys but were excluded from the February 2006 sustainability evaluation. Water and sanitation interventions were not completely funded or maintained using ARC resources. Huitzitzil, Guatemala did not have baseline data collected in 2000 and was using shallow dug wells and bottled water. In Waspam, Nicaragua, only half of the study area received water and sanitation interventions from ARC which resulted in too small a sample of homes. Waspam is also located in a remote rural area in the north east of Nicaragua along the Honduran border and not easily accessible.

Sample Size

For the three-year survey, we calculated the number of household interviews that were needed to detect a statistically significant improvement in hand washing behaviors after the intervention. The FANTA guide indicator for hand washing behaviors assumes proper hand washing occurs in 20% of households prior to an intervention and is predicted to increase to 40% following the intervention. Based upon a probability of alpha = 0.05 and 80% power, a sample size of 91 households in each of the eight study areas was calculated.

For the sustainability evaluation, sample size was calculated on the basis of how many households were needed to conduct statistical analysis of the hand washing behaviors on a regional, rather than local basis. The target sample size for the entire region, represented by six rather than eight study areas, was 94 households or 14-16 households per study area. A systematic sample (every x^{th} household, based upon the size of the community) was done in each study area.

Statistical Analysis

Data from household and community interviews were entered into Epi Info (CDC, 2003) at the end of each day. Data from individual study areas were pooled and descriptive statistics were calculated. Additional analyses were performed by the CDC investigators after their return to Atlanta using SAS Software version 9.1 (SAS, 2002-2003). Key demographic data and other frequency data of interest (e.g., primary water source) were compared to the regional results reported in the 2002 Final Report.

Evaluation Components

Household Interview

The household interview consisted of responding to a household questionnaire, a visual inspection of water and sanitation facilities at the home, a visual evaluation of hand washing and hygiene behaviors of the respondent (preferably the adult responsible for water use in the home), and collection of a household water sample. The 2006 program sustainability household questionnaire was a condensed version of the household questionnaire used in the three-year survey. Three CDC

interviewers, each accompanied by a person from the community, completed the interviews in randomly-selected households.

Household questionnaire

The household questionnaire used in the previous surveys included questions that applied directly to the impact and monitoring indicators of the FANTA Guide (Billig et al., 1999). In the sustainability evaluation, questions were asked of the one person responsible for the family's water use. Questions, not included in the three-year survey, were added to the sustainability evaluation. Specifically, there were questions added regarding events, such as storms or hurricanes, that might have affected the household's access to water or sanitation systems constructed since Hurricane Mitch. We also included open-ended questions to allow the respondent, typically the female head of household, to comment on the adequacy of available water and sanitation systems to meet the family's needs and to discuss any problems encountered with the ARC-funded systems over the years since their construction.

Visual inspection of household water and sanitation systems

Visual inspection of the household water supplies and sanitation facilities conducted by the interviewer used the same protocol that had been employed in the three-year surveys. Interviewers noted whether the household water source could be contaminated by animals, whether drinking water was stored in covered containers and how it was dispensed from containers, and estimated the distance from the home to the primary water source. A summary score for the condition of the latrine was calculated based upon criteria from the FANTA Guide.

Hand washing and hygiene behaviors

The respondent was asked whether they had received instructions on hand washing both during and in the period immediately after Hurricane Mitch and/or in subsequent years. They were asked to demonstrate knowledge of proper hand washing techniques by describing when hands should be washed. They were asked to demonstrate the actions of proper hand washing practice for the interviewer. A standard checklist, identical to that used in the earlier surveys, was used to record the elements of proper hand washing observed by the interviewer. A summary score was calculated. The respondent also was asked whether she had received instruction in water treatment, and whether the household water is regularly treated and the type of treatment.

Water Sampling and Analysis

Water samples were collected for qualitative evaluation from each household and community water system(s) in each study area. Household drinking water samples were collected from water stored in the home. The study participant was asked to give the interviewer a cup of water from the drinking water stored in the home. Water sample results measure the proper handling of water by the family member responsible for water in the home. Tap water samples from the distribution systems were analyzed in a select number of homes in two study areas. Water samples were collected at each community water source and from the distribution system when it reached the community.

All water samples were tested for bacterial contamination with a Hach kit for total coliform bacteria and E.coli. Approximately 100 ml of water from each source was put in a sterile disposable bottle that contained a selective reagent/nutrient broth, MUG. Samples incubated at room temperature for 24 to 48 hours. An ultraviolet light (UV) determined the presence of fluorescence. The following color changes indicated the presence of coliforms:

Presence of total coliforms = yellow
Presence of *E. coli* = yellow + fluorescence
Absence of total coliforms and *E. coli* = red / purple

Water systems that used chlorine were also tested for chlorine residual using the Hach free chlorine test kit.

Community Interview

A CDC interviewer administered the community questionnaire to one or more members of the community water committee in each community. The questionnaire included questions about changes in the community since the installation of the ARC-funded water and sanitation systems, the continuing adequacy of the systems to meet the needs of the community, and problems with the water system or latrines. A copy of the community survey is provided in Appendix C.

Infrastructure Evaluation

A CDC investigator completed the water infrastructure evaluation (in Appendix D) with assistance from members of the ARC. This evaluation included visual inspection of the water storage tanks, the chlorination system (if applicable), the distribution system and pipes, and the community water source(s).

Qualitative water samples were collected at the source to determine if there was bacterial contamination. Water samples were also collected from the distribution system when it reached the community. If chlorine was used then water was tested for chlorine residual.

Results

Table 3 is a summary of data collected in six study areas. Results are summarized by household interviews by each indicator; water sampling results which includes both household and community water sample results; community interview; infrastructure results and overall regional results. A copy of the questionnaire with frequencies of responses has been included in Appendix F.

Table 3. Number of Surveys Completed and Number of Water Samples Collected

Country	Community	Household Survey	Water Samples	Community Survey	Infrastructure Survey
El Salvador	Las Pozas	16	20	1	1
	La Ceiba	16	18	1	1
Guatemala	Plan Shalagua	8	9	1	1
	Guayabo	8	12	1	1
Honduras	Marcovia	16	18	1	1
	Las Lomas	16	18	1	1
Nicaragua	Dipilto Nuevo	7	8	1	1
	Dipilto Viejo	7	10	1	1
Total		**94**	**113**	**8**	**8**

Household Questionnaire Results

Data were collected from 94 households, which covered 536 individuals. On average, five persons lived in each home (range 1 to 13). Forty-one (44%) of the families included at least one child less than 36 months. The families surveyed were similar in demographics to those seen in 2002.

Percent of households with year-round access to improved water source

Ninety percent (85/94) of the households obtained water for domestic use from a community water system by means of a private tap located in the yard and 9% obtained water from a shared community spigot. One person reported obtaining water from a well. The median distance traveled to obtain water for domestic purposes was three meters (range 1 to 2500 meters). An improved water source means direct connection to the home or public facility within 200 meters of the home.

Table 4 is a summary of water availability and storage. Sixty-nine percent of households reported that the tap provided water all day and 76% reported having water available at all times of the year. When evaluating quantity of water used per capita per day using FANTA Guide criteria, only 36% (33/93) were estimated to have an adequate water supply (≥ 50 liters/day per capita). However, 97% of the respondents said that the family had 'enough water' for daily uses. Most homes had a 'pila' which is an uncovered rectangular concrete tank capable of storing several hundred liters of water or a 55 gallon drum at or near the tap. Separate from the water held in the 'pila' or drum, more than 90% of the families had drinking water stored in the home. Eighty-three percent (70/84) of the drinking water containers were observed to be covered. Thirty percent (28/94) of respondents said they had experienced no problems with the water system and had no suggestions for improving the system.

Table 4. Household Water Collection and Storage

	Total Number of Households	Number of Households with Water	Percent %
Households with water all day from tap	94	65	69
Households with water all year from tap	94	71	76
Households with water stored in home	94	88	94
Household with "enough water for daily needs"	94	91	97
Households with drinking water in home	94	87	93
Covered drinking water in home*	84	70	83

* Water storage was not observed in 3 households (3%)

Percent of households with access to a sanitation facility

Ninety-eight percent (92/94) of the households surveyed had access to a latrine, either on the property or at the home of a nearby neighbor or relative. Eighty-eight (96%) of the respondents knew the circumstances under which the latrine they used had been constructed. Seventy-six respondents said a latrine had been built on the property in the period after Hurricane Mitch and 62 of the 76 (82%) were still using the same latrine in 2006. Table 5 is the summary of the evaluation of the sanitation facilities.

Table 5. Household Sanitation Facility Evaluation

	Total Number of Households	Number of Households	Percent %
Have access to sanitation facility	94	92	98
Received latrine post-Mitch*	88	76	86
Same latrine still in use?	76	62	82

* Six respondents did not know when the sanitation facility was constructed.

Percent of households with appropriate hand washing behavior (food preparer)

Hand washing behavior was evaluated using criteria from the FANTA Guide. Ninety-three women responded to this portion of the questionnaire. One husband responded for his sick wife but his responses were not included in this part of the analysis. Overall, 44% (41/93) of the women

interviewed demonstrated appropriate hand washing technique. Results were adjusted for households without children less than 36 months. Adjusted behaviors showed that nearly 60% of women had proper hand washing technique in all surveyed households. Looking at the results separately, when the scores of the study participants with young children were compared to those without children, the difference was statistically significant (p=0.04). Women who did not have children less than 36 months in the home demonstrated better hand washing technique (67% (35/52) than those who did, 46% (19/41). Sixty-eight percent (63/93) of the women interviewed recalled ever having received instruction on hand washing. Forty-one (65%) of the women recalled being instructed and 13 (43%) did not recall ever having instruction on hand washing but displayed proper hand washing techniques. Table 6 is a summary of scoring for appropriate hand washing behavior and past education.

Table 6. Hand Washing Behaviors and Education

	Total Number of Women Interviewed	Number of Women Demonstrating Proper Handwashing Technique	Percent %
Appropriate hand washing behaviors*	93	41	44
Adjusted appropriate hand washing behaviors**	93	54	58
Hand washing education			
Received instruction	63	41	65
Did not receive instruction	30	13	43

* Defined as a score of ≥8 out of 10 for all respondents

** Defined as a score of ≥7 out of 9 for respondents with no children <36 months old in the home AND a score of ≥8 out of 10 for respondents with children <36 months old in the home

Of the 63 women who recalled being instructed, 58 could recall the year or years in which they had been taught proper hand washing techniques; 35 of the 58 (60%) said that the most recent instruction was after 2002.

Percent of population using hygienic sanitation facilities

Ninety-two latrines were inspected by interviewers. Using the FANTA Guide criteria, a latrine was considered hygienic if it had three or fewer flies and no evidence of feces outside the latrine. A latrine was considered 'in use' if there was evidence that it had been cleaned recently, had been swept, there was a path to it, was in good repair and/or there was a lack of spider webs in the latrine. Using these criteria, 73 of the 92 inspected latrines in use (79%) were considered to be hygienic.

Thirty six percent of the women said that they had not been instructed on the use and maintenance of the sanitary facility; 53% could give the year in which they had received instruction; and 10% said they had received instruction, but could not recall when. The range of years of most recent recalled instruction was 1992 to 2006. Table 7 is a summary of the households with good sanitation facilities and the education received on this topic.

Table 7. Household Hygienic Sanitation Facility Evaluation

	Total Number of Households	Number of Households	Percent %
Have access to sanitation facility	94	92	98
Using hygienic sanitation facility	92	73	79
Sanitary facility education			
Received instruction	94	60	64
Did not receive instruction	94	34	36

Water Sampling Results

Water samples were collected from the drinking water stored in the home and from the community water source. Tap water samples were collected in two study areas. Table 7 is a summary of the number and types of all water samples collected and analyzed using the Hach test kit.

Table 8. Total Number of Water Samples

Country	Community	Household Water	Community Water Source / Water Storage Tank	Tap Water
El Salvador	Las Pozas	16	1 / 1	3*
	La Ceiba	16	1 / 1	--
Guatemala	Plan Shalagua	8	1 / 0	--
	Guayabo	8	1 / 1	2
Honduras	Marcovia	16	1 / 1	--
	Las Lomas	15	1 / 1	--
Nicaragua	Dipilto Nuevo	7	0 / 1	--
	Dipilto Viejo	7	1 / 2	--
Total		**93**	**15**	**5**

* One respondent indicated that drinking water was taken directly from the tap and not stored in the home.

Household water sample results

Ninety-one percent (86/94) of respondents reported that they had not treated water collected on the day prior to the interview. Of 84 who responded to the question asking how often they treated water, 76% (64/84) said 'never' and 9% (8/84) said 'always.' The most frequent reason given for not treating water in the home was that it was unnecessary because the water system chlorinates at the storage tank. Table 9 is a summary by community of the distribution of those who never treat drinking water.

Table 9. Household Treatment of Drinking Water

Country	Community	Total Number of Households	Number of Households that Never Treat Drinking Water	Percent %
El Salvador	Las Pozas	16	14	88
	La Ceiba	16	14	88
Guatemala	Chiquimula	16	10	63

Honduras	Marcovia	16	12	75
	Las Lomas	16	8	50
Nicaragua	Nueva Segovia	14	6	43

Forty-two percent (40/94) of the interviewees said they had never received instruction on treating water stored in the home; 47% (44/94) could give the year of at least one presentation they had attended on water treatment; and 11% said they had received instruction, but could not remember when. Eighteen women remembered receiving instruction at least once during the 2000 through 2002 period.

During the interview, the study participant was asked to provide the interviewer a glass of drinking water. Stored drinking water was typically kept in the home in a covered container. Water was either directly poured into a drinking glass or a cup was used to dip into the container. Table 9 are the water results for household water samples. Study areas with a chlorinated water system were likely to have less bacterial contamination.

Table 10. Qualitative Results for Household Water Samples

Country	Community	Total Number of Household Samples	Samples Positive for Coliforms	Samples Positive for *E.coli*	Samples with Negative Results	Chlorinated water system?
El Salvador	Las Pozas	16	8	1	9	**Yes**
	La Ceiba	16	4	0	11	**Yes**
Guatemala	Plan Shalagua	8	8	8	0	No
	Guayabo	8	7	8	0	No
Honduras	Marcovia	16	6	3	9	**Yes**
	Las Lomas	15	14	1	1	**Yes**
Nicaragua	Dipilto Nuevo	7	7	2	0	No
	Dipilto Viejo	7	7	5	0	No
Total		**93**	**66%**	**30%**	**32%**	**4 out of 6**

Tap water samples were collected from the distribution system in two study areas, Las Pozas in El Salvador and Guayabo in Guatemala. The water sample was collected by first wiping down the tap with an antibacterial agent, turning the water on and allowing it to run for half a minute, then directly filling the Hach bottle with 100 ml of water from the tap. This technique is adequate for collecting a tap water sample from the distribution system. The results in Table 11 show that the chlorinated water system did not test positive for *E.coli* when compared to the unchlorinated system.

Table 11. Qualitative Results for Tap Water Samples

Country	Community	Total Number of Tap Water Samples	Samples Positive for Coliforms	Samples Positive for *E.coli*	Samples with Negative Results	Chlorinated water system?
El Salvador	Las Pozas	3	1	0	2	**Yes**
Guatemala	Guayabo	2	2	2	0	No
Total		**5**	**60%**	**40%**	**40%**	

Community water source sample results

Water sources for each study area were also tested. After the infrastructure evaluation a water sample was drawn directly from the source, either from the water storage tank or source (spring), or both. Table 12 is a summary of the results. All sources tested positive for coliforms, except for one. Chlorinated water systems also showed the presence of E.coli in 5 of 6 study areas.

Table 12. Qualitative Results for Community Water Sources

Country	Community	Total Number of Community Water Source Samples*	Samples Positive for Coliforms	Samples Positive for *E.coli*	Samples with Negative Results	Chlorinated water system?
El Salvador	Las Pozas	2	1	1	1	**Yes**
	La Ceiba	2	2	1	0	**Yes**

Guatemala	Plan Shalagua	1	1	1	0	No
	Guayabo	2	2	2	0	No
Honduras	Marcovia	2	0	0	2	**Yes**
	Las Lomas	2	1	1	1	**Yes**
Nicaragua	Dipilto Nuevo	1	1	1	0	No
	Dipilto Viejo	3	3	3	0	No
Total		**15**	**73%**	**67%**	**27%**	**4 out of 6**

* Water samples were from the source and/or storage tank

Four study area water systems used chlorine for disinfection. None of the other systems were disinfecting water delivered to homes. Table 13 is a summary of the chlorine residuals measured in the distribution system.

Table 13. Free Chlorine Residuals in Water Systems Using Chlorine Treatment

Country	Community	Type of Chlorination System	Free Chlorine Levels (ppm)	Location of Sample
El Salvador	Las Pozas[1]	Continuous through tablet chlorinator at tank	0.2	Storage tank at 12 pm
			0.3	4 different homes in various locations in community, 2 pm to 3 pm (all at 0.3 ppm)
	La Ceiba	Continuous through tablet chlorinator at tank	0.7	Storage tank at 1 pm
			0.7	2 different homes in various locations in community, 2 pm
Honduras	Marcovia	Batch chlorination of tank once/day	3.5	Elevated storage tank 4 pm *
			2.0	Sector 1 home closest to tank **
			2.0	Sector 1 home furthest from tank**
			1.5	Sector 2 home closest to tank**

			1.5	Sector 2 home furthest from tank**
	Las Lomas	Continuous through drip chlorinator at tank	0.2	Storage tank at 4:45 pm
			0.4	School tap at 8 am
			0.3	School tap at 5 pm

*Measured during filling of storage tank in afternoon. Does not represent level of chlorine in water delivered to houses.

** Measured while water being delivered to homes in morning

[1] Las Pozas - free chlorine levels are measured in several places in the distribution network every 2 weeks by the water committee. Records of these measurements show consistent chlorine levels of 0.4 ppm during January and February, 2006.

Community Questionnaire Results

Results from the community questionnaire reflect information that was gathered from water committees or other community members (such as fontaneros [plumbers]) who had knowledge of the water and sanitation facilities.

Table 14 is a summary of the key information obtained for each of the study areas. Overall, communities in which there was an active water committee with long-standing members generally had better functioning and maintained water systems. Each study area, except for one, received ARC water and sanitation interventions and hygiene education, however, there were specific issues to each study area that were identified in the community survey. These are described in the following sections.

El Salvador

Las Pozas. The water system was designed for 1040 houses and was not provided by the ARC. Water quality was most recently analyzed by Fundemune (a CARE project) in 2002 and found no contamination or microorganisms in the water. Problems with the system since 2001 include installation of a new pump shut-off valve (by a contractor paid by the water committee) and earthquake damage to the tank which resulted in leaks that have yet to be repaired.

Households with high water usage have an extra charge added to the monthly fee. About half the houses were in arrears in payment during the CDC/ARC visit and 284 households had water service cut off. Houses without water service ask neighbors to share water. Many houses are disconnected because they are uninhabited. The water committee has an account for maintenance and indicated satisfaction with this water system so that they would choose this type of system again.

According to the water committee, only about 40% of the composting latrines are still functioning and/or in use. Some latrines have been damaged by earthquakes and are too costly to fix. The level of access to some type of sanitation facility is probably higher than indicated by this estimate. Nine of 13 (69%) interviewees who indicated they received a composting latrine after Hurricane Mitch were still using them. Some residents had also constructed pit latrines or were sharing latrines with neighboring houses. In addition, a number of the homes in Las Pozas were uninhabited in 2006, so some latrines had fallen into disrepair or had materials salvaged for other building projects. In retrospect the community would have selected simple pit latrines because they are easier to use and require less maintenance, according to the water committee.

Table 14. Community Questionnaire Results							
Country/Community	Water system / Water Source	No. of Households	Collecting Fees for Service?	Account	Water Committee	Sanitation	Education post-2002?
El Salvador							
--Las Pozas	2001 CARE system / Deep drilled well, pumped to storage tank, continuous chlorine tablet treatment, gravity flow to household taps with water meters	690 homes	Yes $3.43 USD per month 248 homes water cut off	Yes $3,306 USD	Yes	In 2001, composting latrines	2001-2002 water, sanitation and hygiene from Health committee
--La Ceiba	2002 ARC system / Spring, gravity flow, pumped to storage tank, continuous chlorine tablet treatment, gravity flow to household taps	100-110 homes 76 connected	Yes $3.00 USD for 6 m^3 water / month	Yes?	Yes?	In 2001, Composting latrines	None after 2002
Guatemala							
--Chiquimula Plan Shalagua	2001 ARC system / Spring, gravity fed to tank, gravity flow to public taps	130 homes	No	No	No	Pit latrines	None after 2002

Guayabo	2001 ARC system / Spring, conduction line to storage tank, chlorine tablet treatment (no longer), gravity flow to household taps	150 homes 126 served	Yes 15 quetzales every 3 months $2.00 USD	No	Yes	In 2001, pit latrines	2001 was last training by the Red Cross
Honduras							
--Marcovia	Since 2001, ARC system / Deep drilled well, submersible pump to storage tank, daily chlorine treatment, gravity flow to homes, water 2 hours/day	240 homes	Yes 35 lmps per month-$1.87 USD Some not all pay	Yes Savings 148,000 lmps ($7,900 USD)	Yes, very active	In 2001, pour flush latrines	2003 Honduran and Swiss Red Cross, water quality, sanitation, hygiene
--Las Lomas	Since 2001, ARC system / Spring, gravity flow to storage tank, drip chlorinator treatment, gravity flow to household taps	400 homes 348 connected	Yes 20 lmps per month-$1.07 USD 303 homes pay for service	Yes 25,000 lmps ($1,336 USD)	Yes	In 2001, 150 pour flush latrines	Oct 2005 Red Cross and Ministry of Public Health, water, sanitation and hygiene

Nicaragua							
--Nueva Segovia Dipilto Nuevo	Since 2002, local municipality system / Stream - filtration treatment, gravity flow to storage tank, household taps	55 homes 42 connected	No 10 cordobas per month – 0.60 USD	No	Yes	Pit latrines ARC 42 homes	Dipilto Health Center, 3 times per year-safe water, sanitation, children's health
Dipilto Viejo	Since 2003, local municipality system / Stream - No treatment, gravity flow to storage tank, household taps	80 homes	No 10 cordobas per month – 0.60 USD	No	Yes, not active	In 2000, Pit latrines	2005 Natural Disaster Health Unit-water, sanitation, and hygiene

Health education was last received in 2001-2002 from the health committee in Las Pozas. Since Hurricane Mitch the community has received food aid (mainly to encourage people to work on construction of the water system) and has been impacted by earthquakes (damage to water system and latrines) and deforestation-related flooding.

La Ceiba. The population in this community is between 600-800 people. There are 100-110 homes with only a portion connected to the water system. Since 2002, the notable problems with the water system have been air locks forming while cleaning the spring box and river crossings washing out during flooding. Flooding from Hurricane Stan washed out some of the gabions (chain link boxes filled with rocks) protecting the conduction line at river crossings. The community water committee performs all repairs and maintenance on the system; there is no fontanero. There is a standard monthly water fee with an extra $.50 per m^3 charged for usage over 6 m^3. Failure to pay after 3 months results in disconnection of water service. Those without water connections (either because they are new homes or the household did not participate in the construction of the original water project) use a neighbor's water, or collect water from the river or pumping station overflow. Revenues from water fees cover necessary maintenance of the water system.

Water quality in La Ceiba has not been analyzed for water contaminants. However, the chlorine vendor will test chlorine levels at no cost when the community purchases lots of 50 or more chlorine tablets. The community has been satisfied with water system construction and design – particularly the distribution valve system that allows for shutting down individual parts of the system when a leak is discovered.

Houses without latrines, those that are new, and those belonging to people who did not participate in the water system construction, have excavated open pit latrines. The open pit latrines are problematic because they flood and overflow during the rainy season.

Health education for the community on water, sanitation and hygiene was provided shortly after completion of the water system by a health committee (now disbanded) formed by ARC. The training emphasized proper use and maintenance of the composting latrines. In addition a Ministry of Health promoter occasionally comes to the community to do in home health education.

Guatemala

Chiquimula consists of two communities, Plan Shalagua and Guayabo.

Plan Shalagua. There are approximately 650 inhabitants (estimated at 5 persons per household) in this community. In September 2005, rain from Hurricane Stan resulted in a landslide that significantly diminished the quantity of spring flow at the source. Consequently the system is barely functioning – only one or two tap stands at the lowest point in the system provide a small volume of water. All households must now obtain water from these taps (which means traveling a distance of a kilometer or more for some households) and bathing/washing is done in a nearby river. The community has been unable to fix the system. Because of these issues, there are no community charges for water, no active water committee and therefore no savings in a water account.

The water quality of the system was analyzed during construction in 2001, possibly by ARC, but no one interviewed knew the results of the analysis. The community would not have selected this source/type of water system. When the landslide reduced source volume, the community located a different source spring above the current source. The municipality is willing to sell Plan Shalagua the new source but the community has not been able to find assistance from an outside entity/organization to explore the feasibility of, and funding for, use of the new source.

Not all houses received pit latrines. Those that don't have latrines dig their own or use the outdoors. The community was provided training in water, sanitation and hygiene by ARC at the time the water system was constructed.

Guayabo. Not all homes are serviced by this water system. Initially, water was treated at the storage tank with a solid chlorine tablet system, but the tablets are no longer available and chlorine is not currently being used. The high mineral content of the water at the source has caused deterioration of the galvanized metal pipe used for part of the conduction line. In addition, because this portion of galvanized pipe runs above ground through a forested area, falling trees sometimes damage the pipeline and the exposed pipe becomes hot, increasing the potential for corrosion. For both of these reasons, repairs to the conduction line have become a frequent occurrence. Maintenance is done by a fontanero and community members. The fees paid every 3 months for water are not enough to cover the costs for the frequent need for repairs and there is no water

savings account. Consequently, when repairs are needed, the water committee goes to the community for extra funds.

There are some houses in the community that are not connected to the water system because they did not want to participate in the construction of the system in 2001. Several previous water projects were started and never completed and some in the community did not think the ARC project would be completed. Households without water connections haul water from old water wells. People interviewed in connection with the Guayabo water system did not know about any previous water quality analysis done in the community.

Some households did not receive pit latrines (the same group that did not want to participate in the water system construction) so they've dug their own latrines or use the outdoors. During the rainy season, pit latrines fill and overflow. The person interviewed by CDC was not on the original water committee and was not part of the process deciding on different options for the water system design and sanitation.

Health education on water, sanitation and hygiene from the Red Cross was last reported to be provided in 2001 and was given to women in the community at the school.

Honduras

Marcovia. Since 2002, the water committee has upgraded the pump to a larger one capable of filling the tank in less time. The water committee bought this pump and paid a contractor to install it. A Spanish NGO and SANAA (the national water company) have also provided assistance with materials, repairs and chlorine for disinfecting the water. Connected households that fail to pay after several months have water service cut off and 'borrow' water from neighbors. During August and September of each year, payment of water fees declines because there's little wage-paying work for community members, and fees collected do not cover operational costs during those months. However, the water committee has built up a surplus and the savings account to pay monthly fees such as 4,000 lempiras ($214 USD) for electricity and 2,300 lempiras ($123 USD) to the fontanero.

The water quality of Marcovia was analyzed most recently in November 2005 by the Honduran Ministry of Health. No analysis report was provided to the community but they were advised the water was uncontaminated. The water committee in Marcovia is very active and told CDC that this system is the best option for this community.

In addition to the problems with the water distribution system, a significant problem with the latrines in Marcovia is that they overflow and do not function properly during the rainy season. The problem is so bad that the community refers to it as a natural disaster due to the standing sewage throughout much of the community in the rainy season. The water committee would have selected a sewer system because of the overflow problem with latrines.

Health education on water quality, sanitation and hygiene was provided in 2001 (CARE) and in 2003 (Honduran and Swiss Red Cross) in Choluteca. The training was directed to the Marcovia Health committee.

Las Lomas. Problems with the water system since 2001 include flow control problems with distribution network valves and the loss of the conduction line from the source to the tank 8 times since 2002. The conduction line problem has been provisionally repaired with leftover construction materials and volunteer labor, but continues to be susceptible to washing out. The Red Cross also provided 250 bags of cement to put in a new intake structure at the source and build walls to protect the conduction line during flooding.

Water service has been cut to 45 houses for non-payment of water service fees or because the houses are vacant. Houses without connections borrow water from neighbors, as do new houses that cannot pay the connection fee of 4,000 lempiras ($214 USD). The water fee is not always enough to cover costs related to maintenance of the water system (e.g. chlorine, salary for the fontanero, supplies).

Water quality is tested every few months, most recently in December 2005 by the Ministry of Public Health. Only one analysis in recent years showed coliform bacteria, all other tests showed no contamination. The community is satisfied with the system and would select the same system given a choice.

As new houses have been built, some households have had latrines built, or dig home-made latrines. During the rainy season, some of the pour/flush latrines overflow and flood the community. Nevertheless the community would select the same type of sanitation technology because most latrines function well.

Health education was provided post-2002. This community also received food aid following Hurricane Mitch. Members of the water committee reported that incidence of diarrhea is rare since the installation of the water and sanitation system.

Nicaragua

Nueva Segovia consists of two communities, Dipilto Nuevo and Dipilto Viejo.

Dipilto Nuevo (Barrio San Agustín). There were 13 more houses than when the water system was first constructed, however, only the original 42 homes are connected to the system. Houses without a water connection share water from neighbors. The community has a functioning water committee of six people and a fontanero who oversees maintenance and cleaning of the filtration system below the water source. The filtration system is not currently working. The quality of water in the distribution system is unknown and has not been tested since initial construction.

New houses cannot be connected to the water system and repairs to system infrastructure cannot be made since there are no savings in the water system account. The water system provides inconsistent service due to drought and damage to the system near the source. We were told that livestock near the source water as well as disturbances due to logging have adversely affected water quality and quantity. The fontanero said that the community was satisfied with the system; however, the catchment structures need to be rehabilitated. Such repairs are being delayed until logging activities end.

The original 42 houses have pit latrines provided by ARC. There is no funding to construct latrines for new homes. Houses without ARC latrines dig pits and cover them with plastic. Health education was provided after ARC interventions; however, diarrheal illness rates (attributed to water quality) were reported to be high in the community according to a health worker interviewed.

Dipilto Viejo (Barrio Solidaridad). The water source for this system is located approximately 7 km from the community. The person who was available to be interviewed had been a member of the water committee for only two months. We were told the water committee had 4 members, but has been in a state of flux and not very active.

The water system has worked well except when road work between the community and source damaged the pipe delivering source water. Received fees and help from the local municipality has covered replacement/fixing of the pipes. The most recent analysis of water quality in the system was conducted in early 2005 but the person we interviewed did not recall the results. The community would select the same water system given the option to choose.

The total number of pit latrines constructed is not known. Those not receiving latrines built their own. A problem with the latrines has been that when they fill, the homeowners need to dig new pits and there's not enough land within each house plot to do so. The community continues to face natural disasters in the form of landslides caused by deforestation in the area which prohibits further development of the land for homes in this area.

Infrastructure Evaluation Results

The results of the infrastructure surveys mainly reflect the observations of the CDC/ARC team from our review of the water and sanitation facilities, as opposed to the community surveys, which reflect self-reported data from the communities.

The infrastructure survey analyzed physical water and sanitation infrastructure and the administrative structures set up to manage that infrastructure. The longer term sustainability of the Red Cross Post-Mitch water and sanitation projects was generally directly related to their level of functioning at the time of the final health impact survey in 2002. The systems that were generally well operated and managed in 2002 continued to be well operated and functioning at the same level in 2006. One exception to this pattern was in Plan Shalagua, Guatemala, where a natural disaster caused major problems with the water system.

El Salvador

Las Pozas. The drinking water system in Las Pozas is functioning as designed, and observations during this assessment and water committee records both indicate that the system appears to be providing adequate disinfection. The largest challenge facing this system at present is financial viability. There were 987 homes connected to the water system in 2002 during the final evaluation of the original CDC assessment, with 925 of them being occupied and receiving water. However, in 2006, there were only 690 homes occupied, as many of the residents had left because of a lack of economic opportunities in the area. According to the water committee, many of the residents who had been relocated to Las Pozas after Hurricane Mitch had returned to the areas they had come from near the coast, where there is work in the fishing and shrimping industries. To simply cover normal operating expenses, the system needs to have approximately 580 subscribers. Since 2002, the community has lost at least 25% of its original residents, and if more than an additional 10% of those residents leave, the water system will not be able to pay its operating costs (see Appendix E for calculations). This financial strain is already evident – the water committee does not have sufficient funds to pay for all necessary repairs to the system. Although they were able to pay a private contractor to install a new shut-off switch for the pump because the original switch was not working properly, they do not have enough funds to pay for fixing minor leaks to the storage tank that were caused by the earthquake in El Salvador in 2001. Because of the nature of this system, it has significant monthly operating costs (e.g., electricity to pay for pumping costs). Since the water committee has less than two months of operating costs in bank accounts, if subscriber fees are not enough to pay those monthly operating costs, the water committee will be unable to keep the system running for very long.

Problems with the composting latrines that were installed in Las Pozas were also evident during this assessment. Although the majority of the people interviewed in the community that received these types of latrines after Mitch were still using them (9/13, 69%), many of the latrines were not being operated properly. For example, drying materials such as ash were not being added and seats were not being covered in many of the latrines, essential steps for these facilities to function properly and not create odor and fly problems. Some of these same problems were also present during the 2002 infrastructure assessment, and the improper operation of many of these latrines has continued.

La Ceiba. The drinking water system in La Ceiba was functioning as designed at the time of this assessment, with water being disinfected by a tablet chlorinator at the storage tank. However, there were also some issues that may lead to larger problems if they are not addressed. The conduction line from the catchment structure to the pumping station has 3 river crossings in which the pipeline crosses the riverbed encased in gabions. When there are high flows in the river, as during the rainy season and Hurricane Stan, the gabions have been washed out, threatening to also wash out the conduction line. The fence around the catchment structure was also broken, allowing access to the source and making it more easily subject to contamination. Composting latrines were also installed in La Ceiba, and most were being operated properly, although some operational problems, such as not adding ashes, were evident.

Guatemala

Chiquimula consists of two communities, Plan Shalagua and Guayabo.

Plan Shalagua. Due to an intervening natural disaster after Hurricane Mitch, Plan Shalagua was not able to maintain proper functioning of the water system as in 2002. In this community, heavy rains associated with Hurricane Stan in 2005 caused a large landslide above and adjacent to the spring source for the water system, virtually drying up the spring. Because of this diminished flow at the source, only a trickle of water arrives at one or two of the original 23 public tap stands. Before the landslide occurred, the water system was still operating at an adequate level according to the community. Nonetheless, there were some issues with the system even before the landslide; the storage tank was small even for a public tap system, and was not adequately protected from contamination as it is located inside a cattle corral. Ventilated dry pit latrines were constructed in Plan Shalagua and appeared to still be functioning well in 2006.

Guayabo. The drinking water system in Guayabo is still functioning but has had many problems with leaks and repairs in the 19 km. conduction from the spring source to the storage tank, due to two factors. First, the water from the spring has a high mineral content, which is contributing to corrosion and causing leaks in the galvanized iron pipeline. In addition, long stretches of this galvanized iron pipeline run above ground through a forested area, and falling trees sometimes break the pipeline.

Repairing these problems is causing some financial strain and monthly water fees are not always sufficient to pay for repairs. Because the water committee has no reserve funds, when additional money is needed for repairs, the committee has to ask residents to make additional contributions beyond their normal monthly water fees. In addition, there are some cracks in the concrete apron covering the seep spring at the catchment, which allow surface water to enter into the collection box that captures water from the spring. Although this system was originally designed to use a solid chlorine tablet disinfection system at the storage tank, this system has not been in use for some time because the chlorine tablets are not available. Ventilated dry pit latrines were also installed in Guayabo, although community members reported that many of them fill up with water during the rainy season and become unusable.

Honduras

Marcovia. In Marcovia, the water system consists of a deep drilled well that pumps to an elevated storage tank, from which water flows by gravity to users. In 2002, this system was providing the level of service that it was designed for, delivering disinfected water to users for approximately two hours per day. In 2006, the system continues to operate according to the original design and deliver high quality water to users, although there are sometimes minor problems in the distribution system with water reaching all homes during the dry season. There is a very active water committee in this community which ensures that the system is maintained and water fees are collected. One of the factors that appears to contribute to this success is the presence of several committed individuals on the committee who have acted as "champions," an element that has been identified in prior work as important for rural water systems (Katko, 1993). Nonetheless, there has been turnover in the membership of the water committee, so it has become somewhat institutionalized and is not necessarily dependent on just one or two specific people. Because of their diligence, the water committee that operates this system has built up a reserve fund of 148,000 Honduran Lempiras ($7,900 USD) for future repairs, and has also replaced the original well pump with a higher capacity pump.

In contrast to the water system, the sanitation systems in Marcovia, which consist of pour-flush latrines, were generally not functioning adequately. The soils in this area are not highly permeable and so are not ideally suited to these types of latrines. According to documents in the community,

ARC did investigate the soils (including performing some soil tests) and originally determined that these types of latrines would work in this location. However, many latrines fill up during the rainy season and are unusable. The water committee said that the community would prefer to have a sewer system installed. The original ARC project also did investigate this alternative, but concluded that operational costs would be too high for the community to support. Because the soils are not highly permeable, there are also problems with grey water pooling on the surface in Marcovia, creating potential vector breeding habitat.

Las Lomas. The gravity flow system in this community was functioning at the time of this assessment, with water being chlorinated at the storage tank before being delivered to users. However, the conduction line from the source to the tank had been washed out 8 times since 2002. The pipeline has been repaired each time by the community using materials left over from the original construction project. Repairs have been provisional and the pipeline is still subject to being washed out. In addition, the catchment structure at the spring source has been rebuilt to capture more water, but, as a consequence, is much more subject to surface contamination.

This community also has a very active water committee, and its members say they treat managing the water system as a small business. For example, every Friday, the two paid fontaneros review the system for leaks and cut water service to any houses that are two months behind in paying water fees. This water committee, like the one in Marcovia, has also benefited from several "champions" who are highly committed to ensuring that the system continues to function and provide service.

The sanitation facilities in Las Lomas consist of pour-flush latrines. This community has also experienced problems with them filling up during the rainy season, although to a lesser extent than in Marcovia.

Nicaragua

Nueva Segovia consists of two communities, Dipilto Nuevo and Dipilto Viejo.

Dipilto Nuevo (Barrio San Agustín) and Dipilto Viejo (Barrio Solidaridad). In Dipilto, the water systems were constructed by the local municipality (not by Red Cross), and were not originally designed or adequately constructed to meet local norms and standards. For example, the

system in Dipilto Nuevo initially had problems with air blocks in the conduction line from the source to the storage tank because no air valves were installed at high points in the line. In addition, the "filters" that were installed below the sources in Dipilto Nuevo were not functioning at the time of this assessment, and, from their size and appearance, likely were never able to actually function effectively as filters to improve water quality. The tap stands at each home were also constructed of PVC pipe, which breaks easily. Tap stands are typically constructed of galvanized iron pipe to avoid this problem. Design problems are also evident in source selection. The sources for both water systems were not providing adequate quantities of water at the time of this evaluation. In addition, the sources are unprotected surface water and highly subject to contamination. Because of these issues, the water systems in Dipilto did not deliver an adequate level of service to users from the beginning. This situation has continued, with a low level of service causing many users to refuse to pay their water fees. This in turn, creates a situation where the water committee has no resources to repair or upgrade the system, continuing a downward spiral toward even lower levels of service.

Regional Results

The 2006 regional results for the USAID FANTA guide indicators are shown in Table 14. Results for the same six study areas are compared to the baseline, 2002 results and the goal. Although the sample sizes were different (569 in 2002 vs. 94 in 2006), these results represent regional outcomes of variables that were measured using sample sizes designed to show statistically significant differences. As shown in the table, there were no statistical differences between the 2002 and 2006 results for water and sanitation infrastructure on a regional basis.

For hygiene education, differences in the number of people demonstrating appropriate hand washing behavior between 2002 and 2006 approached a statistically significant level. The percentage of the population using hygienic sanitation facilities was statistically different between 2006 and 2002. In both of these cases for hygiene education, the outcomes in 2006 were lower than in 2002.

Table 15. USAID FANTA Guide Indicators Regional Results

Intervention (input)	USAID Indicator	Description of Indicator	Baseline* %	2002* %	2006 %	p (2006 vs. 2002)	Goal
Water Infrastructure	Monitoring Indicator # 1	Households with year-round access to improved water source	36	77	76	0.26	100%*
Sanitation Infrastructure	Monitoring Indicator # 2	Households with access to sanitation facility	51	97	98	0.20	100%*
Hygiene Education	Impact Indicator # 3	Appropriate hand washing behavior	20	54 [67]#	44 [58]#	0.07 [0.10]#	50% increase
	Impact Indicator # 4	Population using hygienic sanitation facilities	23	87	73	**<0.001**	75% In use

Bold indicates statistically significant difference

*Percentage based on 6 study areas for comparison to 2006 results

Recalculated as ≥7 out of 9 in homes without young children

(women in homes without young children were not expected to answer that they washed their hands after diapering).

The results in Table 14 are also compared to the goals from the three-year survey. Looking at the results for each intervention, water infrastructure, monitoring indicator #1, had a goal of 100%. Although a goal of 100% is not truly feasible for this indicator, 76% of the households surveyed had year-round access to an improved water source.

Monitoring indicator #2, sanitation infrastructure, also had a goal of 100% set by the ARC. Nearly 100% of the households (98%) had access to a sanitation facility. Most of the study participants who knew the source of funding for their latrine (76/88, 86%) confirmed that they lived in a home that had received a latrine from the post-Hurricane Mitch latrine project. The majority of those latrines (62/76) were still usable.

There are two impact indicators that measure the success of the health education program, appropriate hand washing technique and population using hygienic sanitation facilities. In 2006, the overall percentage of households with appropriate hand washing behavior on a regional basis represented a 50% increase over the 2000 baseline even though in 2006 this indicator decreased from the final results in 2002. There was no statistical difference between the hand washing behaviors in 2002 and 2006, even when adjusted to address the households that did not have children. Looking at subsets of this data showed that woman who did not have children less than 36 months in the home demonstrated a statistically significant and better hand washing technique. Also, the percentage of the population having access to hygienic sanitation facilities decreased from the 2002 results, and was slightly below the goal of 75% usage.

Strengths and Limitations

There are strengths and limitations with every methodology used to perform an evaluation and they should be recognized. The strength to this study is that most communities were not advised in advance of the CDC visit to their community. For example, the ability to demonstrate proper hand washing knowledge and practice in the community could be assessed without any advanced coaching by the local health people. The person interviewed may have had some reservations in answering the questions posed to them by the interviewer who arrived in their community unannounced. The knowledge of appropriate hand washing behavior was evaluated in this sustainability evaluation using the USAID guide which was exactly the same as in the three-year survey.

Other considerations with regard to the results in the sustainability evaluation are the following:

Many of the communities have had significant changes in population in the interval between 2002 and 2006
No attempt was made in 2006 to identify persons who had received health education during the intervention time period
Many of the respondents could not recall when they had received instruction on hygiene, and
Failure to maintain sanitation of a latrine may be due to deteriorated physical condition of the latrine.

Discussion

Regional Results

In the post-Hurricane Mitch projects, ARC concentrated on providing integrated water/sanitation interventions that incorporated both physical infrastructure and hygiene behavior elements. These results show that on a regional basis, the physical infrastructure interventions may have been more sustainable than the hygiene behavior based interventions, such as hand washing and maintenance of hygienic latrines. The regional results showed that the "hardware" interventions of physical infrastructure were sustainable from 2002 until 2006. However, these overall outcomes mask some substantial differences between communities. Some communities were experiencing major problems with physical infrastructure during this sustainability evaluation.

The results also show that emphasis is needed on the "software" components -- such as hygiene education -- to ensure long term sustainability of water and sanitation projects. More information about specific results from the various elements of the sustainability evaluation, household, community and infrastructure surveys and water quality sampling, is provided below.

Household Questionnaires

Households with year-round access to improved water source

In 2006, a higher percentage of the families had a private spigot in the yard (90% v. 80%) and the majority relied on a 'pila' or drums for water storage for domestic purposes. With these mass storage capabilities, even in communities where water was allowed to flow as little as one hour a day, families reported having sufficient water for domestic uses readily available.

In general, residents were not aware of how much water they had collected on any one day.
An attempt was made in 2002 to use the data from water meters to evaluate the amount of water consumed per household. Water meters that were available in select communities did not provide adequate or accurate data for evaluating the per capita water used. Therefore we did not attempt to quantify the amount of water used per household, just that there was sufficient water available for the families needs.

Compared to respondents in 2002, a higher percentage of those in 2006 said the water system did not supply water throughout the year (24.5% v 6.5%). Comments provided by the interviewees indicated that there were water shortages during the rainy season, when pipes from community water sources would break and the community would be without water for several days to weeks. Users often become unwilling to pay for erratic service which results in no funds available for repairs to improve the level of service. Maintaining continuous water service is a key element for sustainability. Continuity of water service may be an important indicator that ARC should consider including in future evaluations of water and sanitation programs.

On a regional basis, the most frequently reported problems with regard to water source fell into three general categories:
1) Seasonal lack of water, often due to disruption of the water infrastructure by rain or floods;
2) The cost (often, rising cost) of community water; and
3) Complaints about the management of the water system, such as not properly draining the tank on a monthly basis for maintenance, diverting the water for other uses such as to wash coffee, a faulty community well, and that the water committee does not work well.

Households with access to sanitation facility

From the household interviews, problems with sanitation facilities were reported in all communities. Many dry pit latrines constructed after Hurricane Mitch 1) had filled up, 2) were nearly filled, or 3) had problems in the rainy season. Many respondents reported digging a new pit when the old ones filled up and reused the structure from the old pit location. Pour flush latrines also were reported to fill up or have tank collapse problems in the rainy season. Composting latrines were usable but were not properly maintained such as using ash and having the seat properly covered.

Appropriate hand washing behavior

Health education by ARC ended in 2002. Other local health agencies, such as the ministry of health and local Red Cross Chapters, continued going to some communities to discuss proper hand washing techniques. Only 68% of the women in 2006 could remember ever having been taught about hand washing, compared to 78% in 2002. The lower percentage may be attributable to the

limited health education that continued in these communities after the construction was completed on the water and sanitation interventions. Also of importance to these results was that there were new residents in these communities who had not received any health education. The goal for the hand washing indicator was for a 50% increase over baseline which was attained by all communities in 2002, except in El Salvador.

Hand washing scores between subgroups of women who did or did not have young children in the home showed a statistically significant difference. The failure to mention the need to wash one's hands after diapering a child may indicate that special attention should be paid to targeting mothers of young children for hand washing instruction.

There was no statistically significant difference (p=0.98) between the scores of those who had been instructed before 2002 and those instructed more recently, indicating good retention of hand washing information. Overall, no differences in hand washing scores were noted based upon how recently the participants had received instruction.

Population using hygienic sanitation facilities

Among women who could recall receiving instruction, a higher percentage of those whose most recent instruction was after 2002 had hygienic latrines in use (86% v. 68%), although these results are not statistically significant.

Qualitative Water Samples

Most water samples from households, the community sources and the tap were positive for coliform bacteria. Water systems that used chlorine treatment at the water source had a greater number of water samples with negative results; however, 35% of all water samples taken were contaminated by *E. coli*. Household water samples in communities where chlorination of the community water supply was occurring still had 18% of the samples positive for *E. coli*.

Reliance on the community water system to adequately treat drinking water is suggested to have increased over the years. Nine percent of the respondents in 2006 reported treating their drinking water that day compared to 30% in 2002 that treated their water. This result may be partially a

reflection of the communities included in this sustainability evaluation, where 4 of the 6 communities were effectively chlorinating their water supplies. One community, Las Lomas in Honduras, reported that they usually chlorinated their water, but didn't during our visit in 2006 because the water level in the tank was low due to drought. This would support the need for household level treatment in some systems.

Figure 1 is a matrix that shows the conclusions that can be drawn based on whether a water system is chlorinated or not. The final boxes highlight the necessity for ongoing health education on household treatment in some or all of these communities. These results indicate that although chlorination was providing better quality water to the homes, improper storage, handling and treatment of water in the home can present a potential for recontamination.

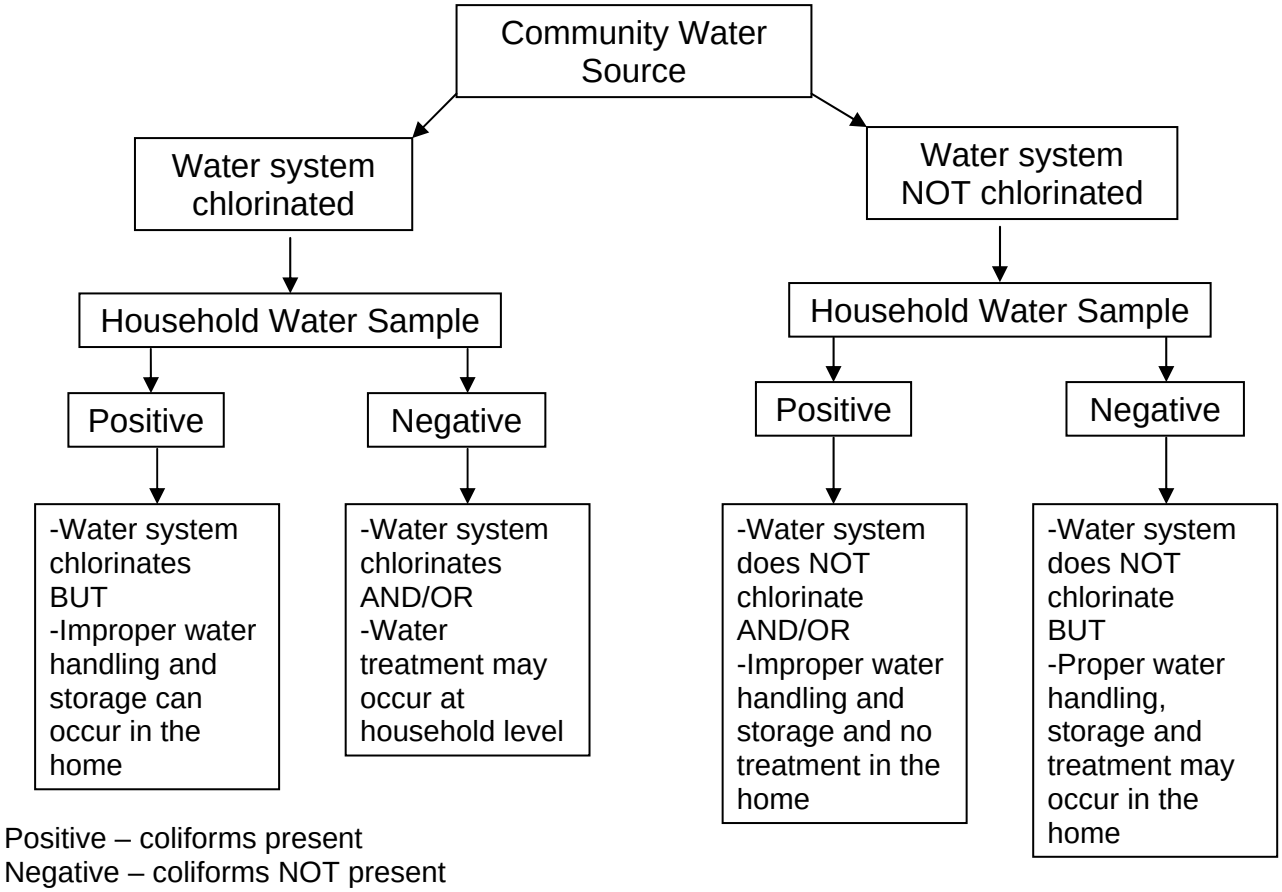

Figure 2. Community Water Source Matrix

Chlorine residual was not measured in household water samples and may have been useful to see if there was any residual left in those water systems that used chlorine. Quantitative testing for coliforms may also be useful in identifying the effectiveness of household versus water system treatment.

Community Questionnaires and Infrastructure Evaluation

An up-front investment in appropriate design and construction that conforms to local norms and standards can have longer term positive impacts on project sustainability. A local administrative structure (like water committees) needs to be put in place to operate and maintain the water and sanitation infrastructure and is a key organizational effort for successful projects.

The findings of the community interview and infrastructure evaluation highlight other issues not fully captured in quantifying the FANTA guide indicators. Specific issues include local demographic trends, water source and water system problems and sanitation facility function. Follow-up support to these communities was also evident even for the communities with functioning water committees.

Local demographic trends

Results from this sustainability evaluation showed that populations in the rural communities served by the ARC projects can change relatively rapidly. These changes can affect infrastructure. For example, in Las Pozas, El Salvador, the population had decreased significantly due to a lack of economic opportunities in the area. This water system has significant operating costs and a continued decrease in population could threaten the financial viability of the water system. The water committee may not be able to collect sufficient water fees to cover those operating costs. If this occurs and the water system either ceases to function or provides only limited service, then the large investment in infrastructure would provide limited (or possibly no) benefits. ARC did not have input into relocating the communities after Hurricane Mitch but is a factor that should be considered in future responses, if possible.

In contrast, Las Lomas Honduras is a rapidly growing community. In 2002, there were 220 homes, with 190 of them connected to the water system. In 2006 there were over 400 houses, with 348

connected to water. Although the water system was originally designed to serve the entire future population of Las Lomas (500 houses), the original spring source did not turn out to have capacity to serve the present number of homes. The catchment structure was already rebuilt to capture more water. The new catchment is not a sealed spring box but a surface impoundment that is subject to contamination. The water system has continuous chlorination at the storage tank which is an additional barrier to any contamination reaching users. The water system is now much more prone to surface contamination at the source due to the new catchment.

Water source - water system

Of the water systems evaluated, the chlorinated systems were delivering better quality water to users. However, chlorine was not available in all areas. In El Salvador, solid chlorine tablets were readily available from local vendors and successfully being used in both water systems. The two systems in Honduras (Marcovia and Las Lomas) were both using powdered chlorine and had been able to secure supplies. In Guatemala and Nicaragua, chlorine was not readily available to the communities, so disinfection of water supplies was not a sustainable option without external technical assistance. Although disinfection of water supplies is an excellent public health intervention, it should not obviate the selection of a good quality, well protected water source, especially in areas where chlorine supplies are not readily available.

Another factor from the infrastructure evaluation was that severe storm events significantly impacted drinking water systems in many cases. Storm events such as hurricanes or even the typical annual rainy season can cause disruptions in a water system. This finding indicates that project design needs to better account for such events, especially to avoid potential washouts from high flows in rivers and streams. Proper source selection and location are important factors.

Sanitation facilities

In terms of sanitation, there were some operational problems with composting latrines in both communities in El Salvador. Composting latrines are a good technical option in some areas but require intense hygiene education that includes long term follow up. During the 2002 assessment, composting latrines were very well operated in Huitzitzil, Guatemala. Unfortunately we were not able to visit this community in 2006 due to time and travel constraints to confirm their

sustainability. Pour/flush latrines were installed in Honduras and also had structural problems and may not have been the best option due to soil conditions.

Follow-up support

Previous work and experience in Central America (e.g., Gelting, 1995) indicate that even well-organized rural communities eventually need external institutional support to ensure sustainability of water and sanitation infrastructure. All visited communities in 2006 received very little follow up after 2002 related to infrastructure. All of them needed additional hygiene education or technical assistance with either water or sanitation facilities installed by ARC.

Follow up work may involve dealing with major problems (such as the landslide drying up the water source in Plan Shalagua, Guatemala), but it also may be as simple as periodic visits with a community to provide a referral to a source of information. Some of the water committees indicated that simply knowing that such external support was available could help to keep up their motivation to operate the water system. Most of these small rural communities in Central America, even the ones that had dealt successfully with major problems or repairs, had been in need of some outside technical assistance at some point. The better-operated systems were able to pay private contractors for some of that assistance because they had diligently collected monthly water fees from users. However, systems that started off with inadequate designs and/or weak local water committees were unable to sustain a level of service that users were willing to pay for, and so did not have funds available to pay for outside assistance.

To the extent that ARC can design programs to provide longer term follow up, the sustainability of these particular projects, as well as future ones, would be enhanced, and large investments in infrastructure would be better protected. In a broad sense, many of the above issues are elements of good project and program design, and proper design promotes sustainability. Ensuring that designs are done effectively take these issues into account but are elements that are not always included in emergency response programs.

FANTA Guide Indicators

The USAID FANTA indicators, listed in Appendix A, include other indicators that we did not focus on with the data collection for this sustainability evaluation because they were of limited utility in the original three-year survey. Two impact indicators and two monitoring indicators were not included in this evaluation.

The percentage of children less than 36 months with diarrhea in the last 2 weeks, impact indicator #1, was excluded since the association with health improvements and the interventions was already demonstrated in the three-year survey. In the 2006 questionnaire (Appendix B), questions concerning diarrhea among children less than 36 months were removed. The rationale for removing these questions was two-fold:

1] in the three-year survey, the results clearly demonstrated that the interventions reduced the incidence of diarrhea in children in these populations and
2] a large sample population had to be surveyed to demonstrate the decrease in the incidence of diarrhea.

Impact indicator #2, quantity of water used per capita per day, in the three-year survey was very inconsistent and did not yield useful information. Using 50 liters per capita per day as the criterion for an adequate supply of water, only 35% of the families were estimated to have an adequate supply of water. However, when asked, 97% of the respondents said they had enough water for the family's domestic needs. These results support the conclusion from the 2002 final report that this metric was not useful.

Data for the two monitoring indicators was not directly collected. Monitoring indicators #3 dealt with the percentage of recurrent costs for water supply services provided by the community served. In the last survey in 2002, only six of the eight water systems had been operating for sufficient time to assess this indicator. Of those six, three (Marcovia, Honduras, and Las Pozas and La Ceiba, El Salvador) were covering 100% of their operating costs. In the sustainability evaluation in 2006, these same three systems were the only ones still covering their monthly operating costs, although they did not all have enough funds to cover needed repairs. For example in Las Pozas in 2006, the

storage tank was leaking, but the water committee did not have sufficient funds to pay for repairs. In addition, as previously discussed, Las Pozas has been rapidly losing population due to a lack of economic opportunities. If this trend continues, the water committee in Las Pozas may face a situation where they are not able to cover their operating costs. In some of the other communities (Guayabo in Chiquimula, Guatemala, for example), monthly water fees do not always cover costs, and in such cases, the water committee asks for additional contributions from community members.

Data on the cost of water was collected for the sustainability evaluation. In U.S. dollars, the median cost of water in the region has risen from $0.90 monthly to $1.86 between 2002 and 2006 among residents who reported paying for water. Mean values ranged from $0.29 in Nueva Segovia, Nicaragua, where half the respondents reported not paying for water, to $4.18 in La Ceiba, El Salvador. This result may indicate that initial water fees were set too low to pay for the actual cost of service, and have risen to reflect those actual costs. The ARC should consider appropriate projection of water fees and level of service that communities will be able to support for future interventions. Communities may have unrealistic expectations about the level of service they are able to support, given what residents are willing and able to pay. For example, in Marcovia, Honduras, water committee members reported during the 2006 evaluation that they would like to install a sewer system because of problems with pour-flush latrines. However, the initial analysis by ARC in 2000 indicated that the community would not be able to financially support that level of infrastructure.

Monitoring indicator #4 is the percentage of constructed water supply systems operated and maintained by the communities served. If adequate maintenance is defined to include the delivery of good quality water to users, then, only the systems that were disinfecting water would be included. Four of the six communities in this sustainability evaluation (Las Pozas and La Ceiba, El Salvador and Marcovia and Las Lomas, Honduras) were adequately disinfecting water delivered to users. Chlorine supplies were not readily available to the other communities. In addition, as previously discussed, even those systems that were adequately maintaining their systems were in need of outside technical assistance at some point. These communities did not always receive such assistance.

Conclusions and Recommendations

In general, the ARC post-Mitch water and sanitation projects were sustainable after 4 years, on a regional basis. However, this general result masks some important differences in results for different program elements as well as important differences among individual communities. Physical infrastructure interventions were generally more sustainable than hygiene behavior interventions, although some communities were also experiencing large scale problems with their physical infrastructure.

Overall, communities in which there was an active water committee with long-standing members had better functioning and maintained water systems, and the systems that were generally well operated and managed in 2002 continued to be well operated and functioning at the same level in 2006 (with the exception of Plan Shalagua, Guatemala, as discussed above). All of the communities would benefit greatly from follow-up from authorities or organizations with water and sanitation skills for problem solving. In addition, all communities, in particular the more isolated ones would benefit from knowing where and how to seek support (financial, materials, technical assistance) for maintaining systems.

Based on the results of the Final Survey in 2002 and the sustainability evaluation of ARC's water and sanitation interventions, CDC's recommendations may be generalizable to all of the water and sanitation interventions that ARC undertakes worldwide. The following recommendations from the 2002 report are still applicable to the sustainability evaluation:

Emphasize even further the provision of strong community-wide hygiene education programs in beneficiary communities before, during, and after physical water and sanitation interventions are implemented.

Provide institutional continuity for ARC's country-level water and sanitation programs in order to provide continuous, effective support to the communities where infrastructure projects are undertaken.

When working with partner organizations, ensure that roles within such partnerships are well-defined and that mechanisms exist to ensure that all aspects of the projects are completed and well integrated.

Work with Ministries of Health and Environment and host-country Red Cross Societies to develop effective mechanisms to provide continued support in the areas of hygiene education and promotion, and infrastructure and water quality monitoring after the completion of the active phase of ARC involvement in water and sanitation intervention projects

Based on the results from the sustainability evaluation, CDC identified the following additional recommendations to consider when implementing future water and sanitation projects in disaster response and development situations:

Ensure that adequate attention is given to forming, training, and providing ongoing support to local administrative structures (like water committees) to operate water and sanitation infrastructure. In some cases, such as with composting latrine projects, a local administrative structure may also be required to ensure the proper ongoing use of sanitation facilities.

Ensure that adequate attention is given to ensuring that water fees are set at a level that will allow sustainable operation of infrastructure.

Develop more focused and effective indicators for water/sanitation/hygiene education programs. For example, this sustainability evaluation suggested that continuity of water service may be an important indicator that was not included, whereas per capita water use did not turn out to be a useful indicator. The World Health Organization's (WHO) qualitative service factors (quality, quantity, continuity, coverage, and cost) may be helpful in developing better indicators (WHO, 1997).

Ensure that site selection and project designs effectively take into account information like local demographic trends, employment opportunities, the possible consequences of severe storm events, and water source capacity to ensure that both communities themselves and interventions are sustainable. Incorporating these elements will require even more investment of time and qualified personnel, elements that are not always included in emergency response programs.

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Appendix A. Performance Indicators

Impact Indicators	Monitoring Indicators
Percentage of children under <36 months with diarrhea in the last 2 weeks	Percentage of households with year-round access to improved water source
Quantity of water used per capita per day	Percentage of households with access to a sanitation facility
Percentage in household with appropriate hand washing behavior ---Child caregivers ---Food preparers	Percentage of recurrent costs for water supply services provided by the community served
Percentage of population using hygienic sanitation facilities	Percentage of constructed water supply systems operated and maintained by the communities served

Billig et al, 1999.

Appendix B. Household questionnaire

Post-Mitch Community Reconstruction Sustainability Evaluation:
Household survey (2006)
Central America - Honduras, Nicaragua, El Salvador, and Guatemala

Country: a. Honduras b. Nicaragua c. El Salvador d. Guatemala
Community: _____
Interviewer: _____ Date:_____ day/month/year Time: _____

A. Household information

Did you participate in this study before? Yes No DK
If *"yes"*, in which year (*mark all that apply*)? 2000 2001 2002

This house is ……..? (*indicate one*)
A. Own house
B. Temporary house/Shelter
C. Friends/family
D. Rental
E. Other_____

How many people normally sleep in this home? _____

Among the people who sleep here, how many are children < 36 months (3 yrs) old? _____

What is the highest level of education that you have completed?
None Grades 1-6 Grades 7-9 High school 10-12 College

B. Use and collection of household water

May I speak to the person who is responsible for the water for the household?

How much water did you gather **yesterday** from all sources for all of your household uses? _____ (liters)

6a. Was it enough for the family's domestic needs? Yes No

How many people, including people who aren't in your family, used the water you collected **yesterday**? _____

Where do you get MOST of your water for drinking and food preparation? (*Indicate one*)

A. shared spigot	D. private well	G. by truck (purchased)
B. private spigot	E. bottled/purchased	H. other:_____
C. shared well	F. river/stream	

How far do you have to go to collect your water? _____varas_____meters _____km
Distance in meters
(interviewer comments: _____varas_____meters _____km)

Are livestock or wild animals able to get into the source waters, wells or pump area?
Yes No DK
(interviewer comments: Yes No DK)

(a) Do you usually have to wait to get your water? A. Always B. Sometimes C. Never

If "*A*" or "*B*", (b) how long do you usually wait? (*read possible answers and indicate one*)
A. Less than 15 minutes B. 15 minutes to ½ hour C. ½ to 1 hour D. More than an hour

(a) Does your water source provide water throughout the day? Yes No DK
If "*no*", (b) for how many hours a day is there water? _____hours

(a) Does your water source provide water throughout the year? Yes No DK
If "*no*", (b) where do you get your water when the source is dry? (*choose one*)

A. shared spigot	D. private well	G. by truck (purchased)
B. private spigot	E. bottled (purchased)	H. other:_____
C. shared well	F. river/stream	

Do you have stored water in the house? Yes No

(a) Do you have drinking water in this house? Yes No
If "*yes*", (b) Is the container where the water is kept covered? Yes No

Could you get me a glass of water as if you would offer it to someone to drink?

If yes, (c) how does the interviewee get the water?
Dips in a ladle (has handle) C. Turns a faucet E. Other_____
Dips in a cup D. Pours it out

(a) Did you treat your water for drinking **TODAY**? Yes No
(b) How often do you treat your drinking water? A. Always B. Sometimes C. Never
If '*A*' or '*B*' (c), how do you treat your water? (D*o not read list of answers. Mark all that apply*)
A. Chlorine B. Iodine C. Boiling D. Other _____ E. Do not treat

How much do you pay per month for the water you receive? _____(currency/month)

Is your water supply operated and maintained by the community? Yes No DK

Have you had any problem or do you have any suggestions regarding your water system?

_____

_____

C. Hygiene behaviors

May I speak with the person who makes the food for the household?
Could you tell me before or after which activities do you wash your hands?
(*Let them answer. **Do not read possible answers, but you can say "are they any other times?***)

After defecation	Yes	No
After cleaning baby's bottoms	Yes	No
Before food preparation	Yes	No
Before eating	Yes	No
Before feeding children	Yes	No

Would you explain and show me what you do when you wash your hands? (***Do not prompt***)
Handwashing technique:

With water Yes No
With soap Yes No
With both hands Yes No
Rub hands together at least 3 times Yes No
Hand drying technique:
On a clean towel/cloth Yes No
Air dry Yes No
On clothing Yes No
Other _____ **33. *Total score:* _____**

34.(a) Is there a place for household members to wash hands? Yes No
If yes, (b) Is there soap? Yes No
If yes, (c) Is there a clean towel or rag for drying hands? Yes No

D. Sanitary facilities

35. (a) Did you receive a latrine after Hurricane Mitch? Yes No
If "*yes*", (b) How many years ago? _____ years
(c) Who gave it to you? _____
(d) Do you now have that same latrine? Yes No
If "*yes*", 36. The latrine is: A. Private B. Shared

If "*no*", 37. (a) What happened to the previous latrine? _____
(b) Do you currently have a latrine? Yes No
If "yes", (c) Who gave it to you? _____
(d) How many years ago? _____ years
(e) The latrine is: A. Private B. Shared

38. Have you had any problem or do you have any suggestions regarding your sanitary facility?
_____

If the house has PRIVATE OR SHARED sanitary facilities, ask or answer questions 35-38.
Inspection of sanitary services *(if the house has them)*

39. What kind of bathroom is in the home?

E. Health education
Have you heard a presentation on ….?
45…treating your water for household use? Yes No

If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

46. a._____ b._____ c._____ d._____
47. a._____ b._____ c._____ d._____
48. a._____ b._____ c._____ d._____

49. (a) Have you shown anyone else how to treat the water? Yes No
If "*yes*", (b) to whom? _____

50… the use and care of your latrine or toilet? Yes No
If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

51. a._____ b._____ c._____ d._____
52. a._____ b._____ c._____ d._____
53. a._____ b._____ c._____ d._____

54. (a) Have you shown anyone else how to use and care for your toilet? Yes No
If "*yes*", (b) to whom? _____

55… handwashing practices? Yes No
If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

56. a._____ b._____ c._____ d._____
57. a._____ b._____ c._____ d._____
58. a._____ b._____ c._____ d._____

59. (a) Have you taught anyone else these handwashing practices? Yes No
If "*yes*", (b) to whom? _____

60. (a) Has this house been affected by some other natural disaster or event that has affected your water and sanitation system? Yes No
(b) if "yes', please describe: _____

Interviewee comments: _____
_____

Interviewer comments: _____
_____

Appendix C. Community Questionnaire

Post-Mitch Community Reconstruction Sustainability Evaluation:
Community Survey (2006)
Central America-Honduras, Nicaragua, El Salvador, and Guatemala

(Present interviewer and qualifications)
Country: a. Honduras b. Nicaragua c. El Salvador d. Guatemala
Community: _____
Interviewer: _____ Date: _____ (day/month/year)
Interviewees: _____

1. How many households are in your community? _____

2. How many people are in your community? _____

3. What kind of water system do you have now? _____

4. (4a) Since when have you had a functioning and completed water system? _____ (day/mo/yr)
(4b) Who installed/provided the system? _____
(4c) Is the system still functioning? Yes No
If no: (4d) When did it stop functioning? _____ (day/mo/yr)
(4e) Why did it stop functioning? _____

5. (5a) Have there been any problems with the system since 2002? Yes No
If yes, please describe: _____
(5b) How is it repaired? _____
(5c) Is this person paid? Yes No
(5d) How is this funded? _____

6. (6a) Have you received help for taking care of the water system from outside of the community since 2002? Yes No
If yes: (6B) from whom?
A. Red Cross B. Local municipality C. NGO
D. Government E. Other _____

7. What is the monthly cost of water to the households receiving water? _____ (per household)

8. (8a) Are the monthly fees collected from the households enough to pay for the operation and maintenance of the water system? Yes No
If no: (8b) Where do the necessary funds come from for maintenance or repair?
_____

9. Is there still a functioning water committee? Yes No

10. Does the water committee have a savings account? Yes No

11. (11a) Are there households in your community that do not receive this water supply? Yes No
If yes: (11b) How do these households get water? _____
(11c)Why don't these household receive water? _____

12. (12a) Is the water treated at a community level? Yes No
If yes: (12b) What kind of treatment? _____
(12c) When was the last time that it was treated? _____ (day/mo/yr)

13. (13a) Has your water been tested for contamination? Yes No
If yes: (13b) When was the last time it was tested? _____
(13c) Who tested it? _____
(13d) What did they find? A. contaminated B. not contaminated
(13e) Type of contamination A. chemicals B. microorganisms
(13f) If known, could you please provide more information about the type of contamination?
Specify type(s) of contamination (chemical/microbial):
_____

14. (14a) Given the choice today, would you choose the same water system option? Yes No
If no: (14b) Why not? _____
(14c) Which would you choose? _____
(14d) Why? _____

15. What kind of sanitation system does your community have? _____

16. What year did this sanitation become available to the community? _____

17. (17a) Are there households in your community that do not receive this sanitation? Yes No
If yes: (17b) What do these households use for sanitation? _____
_____

If yes: (17c) Why don't these households receive these facilities? _____
_____

18. (18a) Given the choice today, would you choose the same sanitation system option for your community? Yes No
If no: (18b) Why not? _____
(18c) Which would you choose? _____
(18d) Why? _____

19. (19a) Has there been any type of training about sanitation, hygiene or use of water?
Yes No Don't Know
If yes: (19b) When? _____ (day/mo/yr)
(19c) Where? _____
(19d) Who was the program geared to? _____
(19e) Who provided the training? _____

20. Is your community receiving any assistance with food, such as Food Aid? Yes No DK

21. (21a) Has this community been affected by any natural disasters or other events since 2002 that have affected the water and sanitation systems? Yes No
If yes, (21b), please describe: _____

Comments_____
_____

Appendix D. Infrastructure evaluation

Infrastructure Sanitary Survey Evaluation

Water System Performance/Design

1. Is the system working? (i.e., water coming out of taps or pump?)
YES NO

2. If working, how many hours per day is water delivered to taps:
16 - 24 hours
8 –16 hours
less than 8 hours
NA (on demand hand pump system)

3. Functionality of components:

a. Catchment structure or well:

All valves function well? (test them)	YES	NO	NA
Cracks or leaks in structures?	YES	NO	NA
Clean inside spring box or behind dam?	YES	NO	NA
Catchment or well structures fenced in?	YES	NO	NA
Are there latrines or other sources of contamination (livestock, cesspools, etc.) within 100 feet of the catchment or well?	YES	NO	NA

If so, what and how far away?

For springs and dams:
what is upstream of the catchment structure? (forest, grazing land, houses, roads, etc.)

For wells:

Hand pump function well? (test it)	YES	NO	NA
Well casing extend 18" above ground or normal flood level?	YES	NO	NA
Top of well casing sealed from surface water, rain water, or contaminants?	YES	NO	NA
Is the well sealed at the ground surface? (i.e, can surface water, rain water, or contaminants enter the well at the ground surface?	YES	NO	NA

b. Conduction line from source to tank:

Leaks in pipes or joints?	YES	NO	NA
Exposed PVC pipe in line?	YES	NO	NA
Clean out valves and air valves working?	YES	NO	NA

c. Storage Tank:

All valves function well?	YES	NO	NA
Cracks or leaks in structure?	YES	NO	NA
Clean inside?	YES	NO	NA
Hatch covers in good shape?	YES	NO	NA
Covers locked?	YES	NO	NA
Tank fenced in?	YES	NO	NA

d. Treatment System:

Is there any treatment system?	YES	NO	NA

If yes, what type:

sedimentation tank
chlorination
other (specify): _____

Is it working? YES NO

e. Distribution Network:

Are there leaks in distribution network?	YES	NO	NA
Are there leaks in domestic connections?	YES	NO	NA
Does water arrive at all taps?	YES	NO	NA

4. Does the design of the system match the design information given to you by the watsan delegate?

YES NO

If no, describe the differences and their significance.

Sanitation Facility Performance/Design
(to be answered by visiting a sample of the latrines constructed in each community)

5. Given the type of latrine constructed, was it built properly?

YES NO Type_____

comments (especially if improperly constructed):

6. Is it being operated properly?

YES NO

comments (especially if improperly operated):

7. Does the design match the design information given to you by the watsan delegate?

YES NO

If no, describe the differences and their significance.

Appendix E. Financial assessment of water system operations in Las Pozas, El Salvador

Financial Summary: January 2006

Total Income = $2,351.40	Cost
Expenses:	
Administration (salaries, electricity, etc.)	$1,110.27
Service (plumbers)	$779.56
Chlorine	$45.00
Total Expenses	$1,934.83
Normal operating expenses	**~$2,000 per month**

Financial Assets on Hand	January 2006
Cash	$197.63
Bank accounts	$2,297.10
Total	**$2,494.73**

Calculation of minimum number of customers to cover operating expenses:

Normal monthly water tariff*	$3.43
Normal operating expenses	$2,000 / 583 connections

*water is metered and high volume consumers pay more, but vast majority of consumers in this residential area pay the standard tariff

Appendix F. Household questionnaire with frequencies

Household ID#_____

Regional Results **June 2006**

Post-Mitch Community Reconstruction Sustainability Evaluation:
Household survey (2006)
Central America - Honduras, Nicaragua, El Salvador, and Guatemala

Country: a. Honduras b. Nicaragua c. El Salvador d. Guatemala
Community: _____
Interviewer: _____ Date:_____ day/month/year Time: _____

A. Household information

1. Did you participate in this study before? Yes No DK

1.	Yes (%)	No (%)	Don't Know (%)
2006	**43 (45.4)**	**43 (45.4)**	**7 (7.5)**
2002	395 (69.7	134 (23.6)	38 (6.7)

If "*yes*", in which year (*mark all that apply*)? 2000 2001 2002

	2000 (%)	2001 (%)	2002 (%)	Don't Know (%)
2006	**6 (14.0)**	**13 (30.2)**	**14 (32.6)**	**10 (23.3)**
2002	29 (7.3)	214 (54.0)	596	

2. This house is ……..? (*indicate one*)
   A. Own house
   B. Temporary house/Shelter
   C. Friends/family
   D. Rental
   E. Other_____

2.	A (%)	B (%)	C (%)	D (%)	E (%)
2006	**84 (89.4)**	**--**	**4 (4.3)**	**5 (5.3)**	**1 (1.1)**
2002	511 (89.8)	2 (0.4)	34 (6.0)	14 (2.5)	8 (1.4)

3. How many people normally sleep in this home? _____

3.	Mean	Median	SD	Range
2006	**5.7**	**5.0**	**2.4**	**1 to 13**
2002	5.1	5.0	2.3	0 to 17

4. Among the people who sleep here, how many are children < 36 months (3 yrs) old? _____

4.	0	1 (%)	2 (%)	>2 (%)
2006	**53 (56.4)**	**28 (29.8)**	**13 (13.8)**	**--**
2002	315 (55.4)	200 (35.2)	51 (9.0)	3 (0.5)

5. What is the highest level of education that you have completed?

5.	0 (%)	1-6 (%)	7-9 (%)	10-12 (%)
2006	**44 (47.8)**	**40 (43.5)**	**6 (6.5)**	**2 (2.2)**
2002	258 (45.3)	280 (49.2)	27 (1.2)	4 (0.7)

B. Use and collection of household water

May I speak to the person who is responsible for the water for the household?

6. How much water did you gather **yesterday** from all sources for all of your household uses? _____ (liters)

6.	n	Mean	Median	SD	Range
2006	**93**	**225**	**209**	**216**	**0 to 1045**
2002	569	332	190	427	0 to 3228

6a. Was it enough for the family's domestic needs?

6a.	
Yes	%
91	96.8

7. How many people, including people who aren't in your family, used the water you collected **yesterday**? _____

7.	n	Mean	Median	SD	range
2006	**94**	**5.7**	**5.5**	**2.5**	**2 to 13**
2002	569	5.1	5.0	2.6	0 to 20

8. Where do you get MOST of your water for drinking and food preparation? (*Indicate one*)

A. shared spigot
B. private spigot
C. shared well
D. private well
E. bottled/purchased
F. river/stream
G. by truck (purchased)
H. other:_____

8.	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
2006	**8 (8.5)**	**85 (90.4)**	**1 (1.1)**	**0**	**0**	**0**	**0**	**0**
2002	87 (15.3)	459 (80.8)	17 (3.0)	2 (0.4)	0	2 (0.4)	1 (0.2)	0

9. How far do you have to go to collect your water? _____varas_____meters _____km

Distance in meters

9.	n	Mean	Median	SD	Range
2006	**49**	**98**	**3**	**376**	**1 to 2500**
2002	566	38.6	4	132	0 to 999

(interviewer comments: _____varas_____meters _____km)

	n	Mean	Median	SD	Range
2006	**90**	**25**	**3**	**95**	**0 to 500**
2002	565	39	5	132	0 to 999

Household ID#_____

10. Are livestock or wild animals able to get into the source waters, wells or pump area?
Yes No DK

10.	n	Yes (%)	No (%)	Don't know (%)
2006	**89**	**3 (3.4)**	**85 (95.5)**	**1 (1.1)**
2002	567	68 (12.0)	399 (70.4)	100 (17.6)

(interviewer comments: Yes No DK)

	n	Yes (%)	No (%)	Don't know (%)
2006	**71**	**3 (4.2)**	**67 (94.4)**	**1 (1.4)**
2002	566	111 (19.6)	339 (59.9)	116 (20.5)

11. (a) Do you usually have to wait to get your water? A. Always B. Sometimes C. Never

11a.	A (%)	B (%)	C (%)
2006	**--**	**--**	**1**
2002	32 (5.6)	33 (5.8)	503 (88.6)

If "*A*" or "*B*", (b) how long do you usually wait? (*read possible answers and indicate one*)
A. Less than 15 minutes B. 15 minutes to ½ hour C. ½ to 1 hour D. More than an hour

12. (a) Does your water source provide water throughout the day? Yes No DK

12a.	Yes (%)	No (%)
2006	**65 (69.2)**	**39 (30.9)**
2002	405 (71.2)	164 (28.8)

If "*no*", (b) for how many hours a day is there water? _____hours

12b.	n	Mean	Median	SD	Range
2006	**28**	**2.8**	**2.0**	**2.4**	**0 to 12**
2002	164	3.1	2.0	4.1	0 to 23

13. (a) Does your water source provide water throughout the year? Yes No DK

13a.	Yes (%)	No (%)	Don't know (%)
2006	**71 (75.5)**	**23 (24.5)**	**0**
2002	465 (81.7)	37 (6.5)	67 (11.8)

If "*no*", (b) where do you get your water when the source is dry? (*choose one*)
A. shared spigot D. private well G. by truck (purchased)
B. private spigot E. bottled (purchased) H. other:_____
C. shared well F. river/stream

13b.	n	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
2006	**22**	**6 (27.3)**	**5 (22.7)**	**1 (4.6)**	**1 (4.6)**	**0**	**6 (27.3)**	**1 (4.6)**	**2 (9.1)**
2002	38	8 (21.1)	4 (10.5)	11 (29.0)	0	0	12 (31.6)	1 (2.6)	2 (5.3)

Household ID#_____

14. Do you have stored water in the house? Yes No

15. (a) Do you have drinking water in this house? Yes No

If "*yes*", (b) Is the container where the water is kept covered? Yes No

	2006			2002		
	Yes (%)	**No (%)**	**DK*(%)**	Yes (%)	No (%)	DK (%)
14. Stored water	**88 (93.6)**	**6 (6.4)**	**0**	527 (92.6)	42 (7.4)	0
15a. Drinking water	**87 (92.6)**	**7 (7.5)**	**0**	548 (96.3)	21 (3.7)	0
15b. Covered water	**70 (80.5)**	**14 (16.1)**	**3 (3.5)**	473 (83.1)	45 (7.9)	51 (9.0)

*DK= don't know

Could you get me a glass of water as if you would offer it to someone to drink?

If yes, (c) how does the interviewee get the water?
Dips in a ladle (has handle) C. Turns a faucet E. Other_____
Dips in a cup D. Pours it out

Year	n	A (%)	B (%)	C (%)	D (%)	E (%)
2006	**92**	**2 (2.1)**	**36 (38.3)**	**10 (10.6)**	**44 (46.8)**	**--**
2002	559	48 (8.6)	233 (41.7)	91 (16.3)	185 (33.1)	2 (0.4)

16. (a) Did you treat your water for drinking **TODAY**? Yes No

16a.	Yes (%)	No (%)
2006	**8 (8.5)**	**86 (91.5)**
2002	171 (30.3)	394 (69.7)

(b) How often do you treat your drinking water? A. Always B. Sometimes C. Never

16b.	n	A (%)	B (%)	C (%)
2006	**84**	**8 (9.5)**	**12 (14.3)**	**64 (76.2)**
2002	565	171 (30.3)	394 (69.7)	0

If '*A*' or '*B*' (c), how do you treat your water? (D*o not read list of answers*. *Mark all that apply*)
A. Chlorine B. Iodine C. Boiling D. Other _____ E. Do not treat

16c.	n	A (%)	B (%)	C (%)	D (%)
2006	**21**	**11 (52.4)**	**0**	**6 (28.6)**	**4 (19.1)**
2002	11	0	0	8 (72.7)	3 (27.3)

17. How much do you pay per month for the water you receive? _____(currency/month)

n	Currency	Mean	Range	Exchange rate	USD
14	Cordobas	5.00	0 to 10	17.30:1	0.29
31	Lempiras	27.74	20 to 35	18.85:1	1.47
16	Quetzales	3.38	0 to 10	7.4:1	0.46
1	Colones*	30.00	--	8.75:1	3.43
31	USD	4.63	0 to 12	1:1	4.63

*One respondent in El Salvador gave the water cost in Colones, not the official currency (USD).

Regional mean and median water cost in US dollars among respondents who reported paying for water

Year	n	Mean	Median	SD	Range
2006	**80**	**$2.55**	**$1.86**	**2.26**	**$0.14 to $12.00**
2002	567	$1.89	$0.90	1.66	$0.21 to $10.50

18. Is your water supply operated and maintained by the community? Yes No DK

18.	Yes (%)	No (%)	Don't know (%)
2006	**92 (97.9)**	**0**	**2 (2.1)**
2002	534 (94.7)	5 (0.9)	25 (4.4)

19. Have you had any problem or do you have any suggestions regarding your water system?

_____

_____

C. Hygiene behaviors

May I speak with the person who makes the food for the household?
Could you tell me before or after which activities do you wash your hands?
(*Let them answer. **Do not read possible answers, but you can say "are they any other times?***)

20. After defecation Yes No
21. After cleaning baby's bottoms Yes No
22. Before food preparation Yes No
23. Before eating Yes No
24. Before feeding children Yes No

Handwashing activities	**2006**		2002	
	n	**%**	n	%
20. After defecation	**72**	**76.6**	494	87.0
21. After cleaning baby	**15**	**16.0**	176	31.0
22. Before food prep	**85**	**90.4**	505	88.9
23. Before eating	**58**	**61.7**	427	75.2
24. Before feeding children	**27**	**28.7**	248	43.7

Would you explain and show me what you do when you wash your hands? (***Do not prompt***)

Handwashing technique:

25. With water Yes No

26. With soap Yes No
27. With both hands Yes No
28. Rub hands together at least 3 times Yes No

Handwashing	**2006**		2002	
	n	**%**	n	%
25. Water	**92**	**97.9**	562	98.8
26. Soap	**81**	**86.2**	489	85.9
27. Both hands	**88**	**93.6**	557	97.9
28. Rub hands	**83**	**88.3**	521	91.6

Hand drying technique:

29. On a clean towel/cloth Yes No
30. Air dry Yes No
31. On clothing Yes No
32. Other _____

Hand drying	**2006**		2002	
	n	**%**	n	%
29. Towel	**55**	**55**	175	30.8
30. Air	**25**	**25**	211	37.1
31. Clothing	**15**	**15**	215	37.8
32. Other	**5**	**5**	11	1.9

33. *Total score:* _____

Total Scores

Year	N	Mean	Median	Range
2006	**93**	**7.3**	**7.0**	**2 to 10**
2002	306	8.2	9.0	2 to 10

34.(a) Is there a place for household members to wash hands? Yes No

If yes, (b) Is there soap? Yes No

If yes, (c) Is there a clean towel or rag for drying hands? Yes No

	2006		2002	
	n	**%**	n	%
34a. Place	**90**	**95.7**	537	94.4
34b. Soap	**77**	**81.9**	466	81.9
34c. Towel	**33**	**35.1**	166	29.2

D. Sanitary facilities

35. (a) Did you receive a latrine after Hurricane Mitch? Yes No
If "*yes*", (b) How many years ago? _____ years

(c) Who gave it to you? _____
(d) Do you now have that same latrine? Yes No
If "*yes*", 36. The latrine is: A. Private B. Shared

Sanitary facility	**2006**		2002	
	n	**%**	n	%
35a. Post-Mitch latrine?				
Yes	**76**	**80.9**	N/A	
No	**12**	**12.8**		
Don't know	**6**	**6.4**		
35d. Same latrine?				
Yes	**62**	**81.6**	N/A	
No	**14**	**18.4**		
36. Latrine is:				
Private	**60**	**96.8**	N/A	
Shared	**2**	**3.2**	N/A	

If "*no*", 37. (a) What happened to the previous latrine? _____
(b) Do you currently have a latrine? Yes No
If "yes", (c) Who gave it to you? _____
(d) How many years ago? _____ years
(e) The latrine is: A. Private B. Shared

	2006	
	n	%
37b. Have latrine*		
Yes	29	30.9
No	3	3.2
37e. Latrine is:		
Private	29	100
Shared	0	0

Total number of people who have latrines in 2006 compared to 2002

	2006*		2002	
Have latrines	n	%	n	%
Private	89	97.8	547	96.1
Shared	2	2.2	6	1.1
Don't have	0	--	16	2.8

38. Have you had any problem or do you have any suggestions regarding your sanitary facility?

_____

_____

If the house has PRIVATE OR SHARED sanitary facilities, ask or answer questions 35-38.
Inspection of sanitary services *(if the house has them)*

39. What kind of bathroom is in the home?
A. Don't have (go outside) C. Compost latrine E. Other_____
B. Dry pit latrine D. Flush latrine
40. Does it look like some one has cleaned the latrine recently (with water)? Yes No

41. Are there feces outside of toilet/latrine? Yes No
42. Are there flies? (*indicate one answer*) None (0) Few(1-3) Many (4+)
43. Are there signs of use of sanitary facilities?
path to outhouse Yes No
well swept Yes No
in repair Yes No
absence of spider webs Yes No
other: _____
44. Is there toilet paper? Yes No (*check for other cleaning material*_____)
44a. Is the toilet covered?

	2006		2002	
	Yes	**%**	Yes	%
39a. Don't have	**2**	**2.1**	16	2.8
b. Dry pit	**40**	**42.6**	218	38.3
c. Compost	**25**	**26.6**	160	28.1
d. Flush	**25**	**26.6**	174	30.6
e. Other	**2**	**2.1**	1	0.2
40. Cleaned?	**64**	**68.1**	429	78.6
41. Feces?	**12**	**12.8**	37	6.7
42. None	**68**	**75.6**	429	77.7
Few	**15**	**16.7**	100	17.1
Many	**7**	**7.8**	23	4.2
43a. Path	**88**	**93.6**	505	91.5
b. Swept	**73**	**77.7**	431	78.1
c. Repair	**79**	**84.0**	22	4.0
d. Webs	**88**	**93.6**	39	7.1
e. Other	**--**	**--**	4	0.7
44. Paper ?	**70**	**74.5**	354	64.3
44a.Covered?	**32**	**34.0**	N/A	N/A

E. Health education

Have you heard a presentation on ….?
45…treating your water for household use? Yes No
If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?
46. a._____ b._____ c._____ d._____
47. a._____ b._____ c._____ d._____
48. a._____ b._____ c._____ d._____
49. (a) Have you shown anyone else how to treat the water? Yes No
If "*yes*", (b) to whom? _____

50… the use and care of your latrine or toilet? Yes No
If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?
51. a._____ b._____ c._____ d._____
52. a._____ b._____ c._____ d._____
53. a._____ b._____ c._____ d._____
54. (a) Have you shown anyone else how to use and care for your toilet? Yes No
If "*yes*", (b) to whom? _____

Household ID#_____

55… handwashing practices? Yes No
If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?
56. a._____ b._____ c._____ d._____
57. a._____ b._____ c._____ d._____
58. a._____ b._____ c._____ d._____
59. (a) Have you taught anyone else these handwashing practices? Yes No
If "*yes*", (b) to whom? _____

Received health education	**2006**		2002	
	Yes	**%**	Yes	%
45. Water treatment	**56**	**59.6**	445	78.4
50. Latrine use/maintenance	**60**	**63.8**	457	80.7
55. Hand washing	**64**	**68.1**	445	78.4

60. (a) Has this house been affected by some other natural disaster or event that has affected your water and sanitation system? Yes No

60.	**Yes**	**%**
Disaster	**12**	**12.9**

(b) if "yes', please describe: _____

Interviewee comments: _____
_____

Interviewer comments: _____
_____